IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

APPELLANTS' MAIN BRIEF ON APPEAL

COPY OF PAPERS ORIGINALLY FILED

APPELLANTS: Takayuki GOMI; Hiroaki AMMO

ATTORNEY DOCKET NO.: 09792909-3746

SERIAL NO.: 08/965,286 GROUP ART UNIT: 2811

FILED: November 6, 1997 EXAMINER: O. Nadav

TITLE: **SEMICONDUCTOR DEVICE INCLUDING HIGH SPEED TRANSISTORS AND HIGH VOLTAGE TRANSISTORS DISPOSED ON A SINGLE SUBSTRATE**

Commissioner for Patents
Washington, D.C. 20231

SIR:

Appellants is submitting herewith, in triplicate, Appellants' Main Brief on Appeal under 37 C.F.R. §1.192 in support of the appeal filed on February 8, 2002.

The Commissioner is hereby authorized to charge any fee due not paid by check and to credit any overpayment in fees associated with this communication to Deposit Account No. 19-3140. A duplicate copy of this sheet is enclosed.

Respectfully submitted,
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Dated: February 8, 2002

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CERTIFICATE OF MAILING

I hereby certify that this original and two copies of this correspondence is being deposited with the United States Postal Service in an envelope addressed to: Board of Patent Appeals and Interferences, Commissioner for Patents, Washington, D.C. 20231 on February 8, 2002.

Rose M. Garza Date: February 8, 2002

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Commissioner for Patents
Washington, D.C. 20231

SIR:

In accordance with the provisions of 37 C.F.R. §1.192, Appellants herewith submits this Brief in support of the Appeal of the above-referenced application.

REAL PARTY IN INTEREST:

The real party in interest in the present appeal is the Assignee, Sony Corporation - a Japanese Corporation. The assignment was recorded in the U.S. Patent and Trademark Office on December 10, 1996 at Reel/Frame 8347/0382.

RELATED APPEALS AND INTERFERENCES:

There are no related appeals and no related interferences.

STATUS OF CLAIMS:

Claims 1, 3-4, 6, and 20-29 are pending in the application. The present appeal is directed to claims 1, 3-4, 6, and 20-29, which were finally rejected in an Office Action dated November 9, 2001. Claims 1, 3-4, 6, and 20-29 are attached to this Brief in an Appendix.

The status of the claims on appeal, Claims 1, 3-4, 6, and 20-29, is as follows:

Claims 27-29 stand rejected under 35 U.S.C. §112, second paragraph.

Claims 1, 3-4, 6, 21, 23, and 25-26 stand rejected under 35 U.S.C. §103(a) as unpatentable over Kumamaru (U.S. 4,379,726).

Claims 1, 3-4, 6, 21, 23, and 25-26 stand rejected under 35 U.S.C. §103(a) as unpatentable over Watanabe (U.S. 4,258,379).

Claims 20 and 24 stand rejected under 35 U.S.C. §103(a) as unpatentable over Kumamaru (U.S. 4,379,726).

Claim 22 stands rejected under 35 U.S.C. §103(a) as unpatentable over Kumamaru (U.S. 4,379,726) in view of Admitted Prior Art.

Claim 22 stands rejected under 35 U.S.C. §103(a) as unpatentable over Watanabe (U.S. 4,258,379) in view of Admitted Prior Art.

Claims 27 and 29 stand rejected under 35 U.S.C. §103(a) as unpatentable over Kumamaru (U.S. 4,379,726) in view of Watanabe (U.S. 4,258,379).

Claim 28 stands rejected under 35 U.S.C. §103(a) as unpatentable over Kumamaru (U.S. 4,379,726) and Watanabe (U.S. 4,258,379) as applied to claim 27, and further in view of Admitted Prior Art.

STATUS OF AMENDMENTS:

The last response filed in this matter was Response "I" to the August 1, 2001 non final Office Action. Response "I" was received by the USPTO on October 5, 2001. The Examiner addressed the claim amendments of Response "I" on the merits in the November 9, 2001 final Office Action. The November 9, 2001 final Office Action is now being appealed. Accordingly, all amendments have been entered prior to the appeal.

SUMMARY OF THE INVENTION:

Transistors in a semiconductor device conventionally include an epitaxial layer. The thickness and impurity concentration of the epitaxial layer provide a particular point, that is to say, a breakdown voltage point at which current is permitted to pass. Depending on aspects

of the thickness and impurity concentration of the epitaxial layer, the semiconductor device may include a high speed transistor or high voltage transistor.

The voltage breakdown requirements for an epitaxial layer of a high speed transistor conflict with the voltage breakdown requirements for an epitaxial layer of a high voltage transistor. (Specification at page 7, lines 20-22) This conflict creates problems when both a high speed transistor and a high voltage transistor are formed on the same substrate.

The invention relates to a semiconductor device 105 having both a high speed transistor 101 and a high voltage transistor 102 formed on the same substrate 111. (Specification at page 1, lines 4-7; see also Fig. 5) The semiconductor device 105 of the present invention overcomes the conflict problems related to the epitaxial layer requirements for high speed and high voltage transistors through new semiconductor device formation and structure that is not taught or suggested in the cited art.

As seen in Fig. 5 of the Specification, the substrate 111 includes a first surface that defines a datum, a base layer 132, and a base layer 152. Moreover, the substrate 111 includes a high speed diffusion layer 131 and a high voltage diffusion layer 151.

The base layer 132 and the base layer 152 are located the same distance from the datum. Moreover, a first surface of the high speed diffusion layer 131 is disposed above the datum at a first height. Further, a first surface of the high voltage diffusion layer 151 is disposed at a second height that is substantially at the datum. This sets up a structure where a particular distance exits between the base layer 132 and the high speed diffusion layer 131 relative to the particular distance between the base layer 152 and the high voltage diffusion layer 151.

The substrate 111 also includes one epitaxial layer 112 that services both the high speed transistor 101 and the high voltage transistor 102. This epitaxial layer 112 is disposed between the first surface of the high speed diffusion layer 131 and a lower surface of the base

layer 132. Moreover, only the epitaxial layer 112 is disposed between the high voltage diffusion layer 151 and a lower surface of the base layer 152. Here, there is no intertwining impurities from different layers near the base layer 152.

The impurity concentrations of the layers are particularly defined as well. As seen in Fig. 6, the high speed (HS) diffusion layer 131 comprises a peak impurity concentration (HSPIC) value. As seen in Fig. 7, the high voltage (HV) diffusion layer 151 comprises a peak impurity concentration (HVPIC) value. When comparing the two peaks with respect to their impurity concentration, it can be seen from Fig. 6 and Fig. 7 that the high voltage peak impurity concentration (HVPIC) value is less than the high speed peak impurity concentration (HSPIC) value.

Some of the impurity concentrations of the high voltage diffusion layer 151 (Fig. 7) are located between the high voltage peak impurity concentration (HVPIC) and the epitaxial layer 112. Each impurity concentration of the high voltage diffusion layer that is located between the high voltage peak impurity concentration (HVPIC) and the epitaxial layer 112 is higher than each impurity concentration of the epitaxial layer 112 that is located between the first surface of the high voltage diffusion layer 151 and the lower surface of the high voltage base layer 152.

ISSUES:

The issues on Appeal are as follows:

Whether claims 27-29 fail to particularly point out and distinctly claim the subject matter that Appellants regards as the claimed invention.

Whether the subject matter of claims 1, 3-4, 6, 21, 23, and 25-26 would have been obvious to a person of ordinary skill in the art at the time of the invention, under the provisions of 35 U.S.C. §103(a), based on the teachings of Kumamaru (U.S. 4,379,726).

Whether the subject matter of claims 1, 3-4, 6, 21, 23, and 25-26 would have been obvious to a person of ordinary skill in the art at the time of the invention, under the provisions of 35 U.S.C. §103(a), based on the teachings of Watanabe (U.S. 4,258,379).

Whether the subject matter of claims 20 and 24 would have been obvious to a person of ordinary skill in the art at the time of the invention, under the provisions of 35 U.S.C. §103(a), based on the teachings of Kumamaru (U.S. 4,379,726).

Whether the subject matter of claim 22 would have been obvious to a person of ordinary skill in the art at the time of the invention, under the provisions of 35 U.S.C. §103(a), based on the teachings of Kumamaru (U.S. 4,379,726) in view of Admitted Prior Art.

Whether the subject matter of claim 22 would have been obvious to a person of ordinary skill in the art at the time of the invention, under the provisions of 35 U.S.C. §103(a), based on the teachings of Watanabe (U.S. 4,258,379) in view of Admitted Prior Art.

Whether the subject matter of claims 27 and 29 would have been obvious to a person of ordinary skill in the art at the time of the invention, under the provisions of 35 U.S.C. §103(a), based on the teachings of Kumamaru (U.S. 4,379,726) in view of Watanabe (U.S. 4,258,379).

Whether the subject matter of claim 28 would have been obvious to a person of ordinary skill in the art at the time of the invention, under the provisions of 35 U.S.C. §103(a), based on the teachings of Kumamaru (U.S. 4,379,726) and Watanabe (U.S. 4,258,379) as applied to claim 27, and further in view of Admitted Prior Art.

GROUPING OF CLAIMS:

The claims do not stand or fall together except as follows:

(I) claims 1, 3, 22-23, and 25-26 stand or fall together solely for the purpose of this appeal;

(II) claim 4 stands or falls by itself;

(III) claim 6 stands or falls by itself;

(IV) claim 20 stands or falls by itself;

(V) claim 21 stands or falls by itself;

(VI) claim 24 stands or falls by itself;

(VII) claim 27 stands or falls by itself;

(VIII) claim 28 stands or falls by itself; and

(IX) claim 29 stands or falls by itself.

However, Appellants reserves the right to pursue the subject matter of the above claims and other subject matter separately in any continuation application.

ARGUMENT:

I. CLAIMS 27-29 PARTICULARLY POINT OUT AND DISTINCTLY CLAIM THE SUBJECT MATTER THAT APPELLANTS REGARDS AS THE CLAIMED INVENTION

The Examiner rejected claims 27-29 under 35 U.S.C. §112(2) as failing to particularly point out and distinctly claim the subject matter that Appellants regards as the claimed invention. The Examiner notes the following language of claim 27 as being indefinite:

> "*each impurity concentration of the high voltage diffusion layer* ***being*** *located between the high voltage peak impurity concentration (HVPIC) and the datum*" (emphasis added).

The Examiner states that this language makes it unclear as to the location of each impurity concentration. However, claim 27 recites the following language:

*"**wherein** each impurity concentration of the high voltage diffusion layer **that is** located between the high voltage peak impurity concentration (HVPIC) and the datum"* (emphasis added).

Rather than identifying the location of each impurity concentration, the language of claim 27 is directed to those impurity concentrations located between HVPIC and the datum. An example of the location of these impurity concentrations may be seen in Figure 7 of the Specification. In Figure 7, the impurity concentrations are located in the second embedded diffusion layer 151 between the peak of the shown curve and the interface (datum) between the epitaxial layer 112 and the second embedded diffusion layer 151. Thus, claims 27-29 particularly point out and distinctly claim the subject matter that Appellants regards as the claimed invention. Accordingly, Appellants respectfully requests that the Board reverse the Examiner's rejection of the claims.

II. CLAIMS 1, 3, 22-23, and 25-26 ARE NOT OBVIOUS

The Examiner rejected claims 1, 3, 22-23, and 25-26 under 35 U.S.C. §103(a) as unpatentable over Kumamaru (U.S. 4,379,726) or Watanabe (U.S. 4,258,379). However, the Examiner has not made an adequate showing that independent claim 1 is obvious in view of the cited art. Thus, independent claim 1 is not obvious. Moreover, claims 3, 22-23, and 25-26 are not obvious by reason of their dependency on claim 1.

A. Kumamaru

Claim 1 recites:

a second embedded diffusion layer formed ... directly on the substrate

The Examiner presents Kumamaru Figure 10 as teaching the claimed semiconductor device. In Office Actions prior to the appealed Office Action, the Examiner employed element 5a (Figure 8) as teaching the second embedded diffusion layer. Where the Examiner

employed element 5a (Figure 8) as teaching the second embedded diffusion layer, Appellants overcame the Examiner's obviousness rejections.

In the appealed Office Action, the Examiner now states at page 3, line 11 that region 13 (Kumamaru Fig. 8) teaches a second embedded diffusion layer 13. At page 12, lines 4-6 of the appealed Office Action, the Examiner states that "layer 13 of Figure 8 was cited as a courtesy and convenience to Appellants to identify which layer of Figure 10 was cited in the rejection." However, at page 3, line 4 of the appealed Office Action, the Examiner inconsistently states that region 13 teaches the second vertical type transistor as recited in the preamble to claim 1. Kumamaru region 13 cannot teach both the second vertical type transistor and the second embedded diffusion layer of the claimed invention. The Examiner has not commented on this inconsistency.

By the Examiner's statement that "layer 13 of Figure 8 was cited as a courtesy and convenience to Appellants to identify which layer of Figure 10 was cited in the rejection," Appellants understand that the Examiner is citing the lower portion of layer 11 in Kumamaru Figure 10 that is formed directly on layer 12 as teaching the second embedded diffusion layer of the claim. In the appealed Office Action, the Examiner cites the upper portion of layer 11 to teach the claimed epitaxial layer (Office Action, page 3, line 7). However, the lower portion of layer 11 and the upper portion of layer 11 are not distinct layers. As seen in Figure 10, the hatch markings of layer 11 extend without interruption from the upper portion of layer 11 to the lower portion of layer 11 so as to characterize this structure as a single layer 11. Moreover, Kumamaru refers to both the upper portion of layer 11 and the lower portion of layer 11 as epitaxial layers. (Kumamaru col. 3, lines 16, 27-28) Thus, Kumamaru would not teach a skilled person to partition layer 11 to teach the claimed epitaxial layer and the claimed second embedded diffusion layer.

Even assuming that Kumamaru layer 13 of Figure 8 teaches the claimed second embedded diffusion layer, layer 13 of Figure 8 is not formed on the substrate 1, 5. To this, the Examiner states on page 12, lines 9-10, "it is unclear how converting a section of a substrate 5 into a region 13 would not result in the region 13 being located directly on the substrate 5." As seen in Kumamaru Figures 8, 9, and 10, the impurity region 10 of Figure 7 extends down to buried layer 12 so that the resulting product is a layer 13 of Figure 8 formed directly on buried layer 12, not on the substrate 1, 5. Thus, Kumamaru does not teach the above subject matter.

Since the July 25, 2000 Office Action, this Brief essentially is the sixth time over the past year and a half that Appellants has argued in writing with the Examiner over the teachings of Kumamaru with regard to layer 12. Prior to the appealed Office Action, the Examiner never commented on layer 12 of Kumamaru Figure 10.

For example, in the July 25, 2000 Office Action on page 3, lines 11-18, the Examiner asserted that a skilled person would understand layer 5a of Kumamaru as teaching the second embedded diffusion layer of the claimed invention and Kumamaru region 13 as teaching the second vertical type transistor as recited in the preamble to claim 1. In the next three Office Actions, the Examiner maintained that a skilled person would understand layer 5a of Kumamaru as teaching the second embedded diffusion layer of the claimed invention. In the Office Action being appealed (November 9, 2001 Office Action), the Examiner now states that a skilled person would understand region 13 of Kumamaru Figure 8 as teaching the second embedded diffusion layer of the claimed invention and that region 13 of Kumamaru also teaches the second vertical type transistor as recited in the preamble to claim 1. Adding to the inconsistency, the Examiner also asserts in the appealed Office Action on page 6, lines 5-6 that a skilled person would understand Kumamaru region 13 and embedded layer 12 as teaching the second embedded diffusion layer of the claimed invention.

In view of the above, the Examiner has failed to comment on how a skilled person would understand the following: that layer 5a and region 13 of Kumamaru teach the second embedded diffusion layer of the claimed invention; that region 13 of Kumamaru teaches both the second embedded diffusion and the second vertical type transistor as recited in the preamble to claim 1; and that Kumamaru region 13 and embedded layer 12 teach the second embedded diffusion layer of the claimed invention.

A reason for the Examiner's silence is that the Examiner presents Kumamaru buried layer 14 (Figure 10) as teaching the first embedded diffusion layer of the claimed invention. With the understanding that buried layer 14 teaches the first embedded diffusion layer of the claimed invention and that Kumamaru teaches layer 11 and layer 5a as epitaxial layers (Kumamaru col. 3, line 16, lines 27-28, respectively), a skilled person viewing Figure 10 would conclude that layer 12 of Kumamaru Figure 10 corresponds to the second embedded diffusion layer of the claimed invention. However, if layer 12 of Kumamaru Figure 10 corresponds to the second embedded diffusion layer of the claimed invention, then several other limitations of claim 1 would not be taught by Kumamaru.

For example, the second embedded diffusion layer 12 of Kumamaru does not have a different conductive type than the first embedded diffusion layer 14 of Kumamaru as required by the claimed invention. Moreover, the impurity concentrations and relative peak positions recited in the claim clearly would not be taught by Kumamaru. Thus, the Examiner has continued to reject the present claims under 35 U.S.C. §103(a) by inconsistently Kumamaru element numbers 5a, 11, and 13 and the visual images of Figure 10 and Figure 8, irrespective of the teaching of Kumamaru with regard to layer 12.

Claim 1 recites:

wherein the second embedded diffusion layer ... includes an impurity concentration that is less than the impurity concentration of the first embedded diffusion layer.

The Examiner presents Kumamaru buried layer 14 (Figure 10) as teaching the first embedded diffusion layer. Layer 14 (Figure 8) is formed from the upward diffusion of arsenic from region 8 (Figure 7) into layer 11 (Figure 8). Kumamaru does not have, nor has the Examiner cited, any teaching or suggestion with respect to the impurity concentration of layer 14. Without any teaching or suggestion with respect to the impurity concentration of layer 14, the Examiner has no basis for asserting that Kumamaru teaches a second embedded diffusion layer having an impurity concentration that is less than an impurity concentration of a first embedded diffusion layer.

The Examiner presents region 13 (Figure 8) as teaching the second embedded diffusion layer. Kumamaru does not have, nor has the Examiner cited, any teaching or suggestion with respect to the impurity concentration of region 13. Without any teaching or suggestion with respect to the impurity concentration of region 13, the Examiner has no basis for asserting that Kumamaru teaches a second embedded diffusion layer having an impurity concentration that is less than an impurity concentration of a first embedded diffusion layer.

Since Kumamaru does not have any teaching or suggestion with respect to the impurity concentration of layer 14 or the impurity concentration of region 13, Kumamaru does not teach or even suggest the above subject matter.

Claim 1 recites:

wherein the second embedded diffusion layer includes an impurity concentration that ... is equal to or higher than that of the epitaxial layer

The Examiner presents Kumamaru epitaxial layer 11 (Figure 10) as teaching the recited epitaxial layer. Kumamaru teaches that the impurity concentration of epitaxial layer 11 (Figure 10) is $1 \times 10^{14} / cm^3$ to $5 \times 10^{14} / cm^3$. (Kumamaru col. 4, lines 21-25)

The Examiner presents region 13 (Figure 8) as teaching the second embedded diffusion layer. Kumamaru teaches at col. 3, lines 24-25 that region 13 (Figure 8) is formed

as a result of heating the device to 1,200 deg. C to diffuse layer 10 (Figure 7) down into layer 5 (Figure 8) and throughout layer 11 (Kumamaru col. 3, lines 46-51). Kumamaru does not have, nor has the Examiner cited, any teaching or suggestion with respect to the impurity concentration of region 13. Accordingly, Kumamaru does not teach or suggest the above subject matter.

Region 13 is formed by the diffusion of layer 10 (Fig. 7). Region 13 extends from at least base 17, base 18, and collector 20 (Kumamaru col. 3, lines 46-51) to buried layer 12 so as to occupy a portion of the epitaxial layer 5 and a portion of the upper contiguous epitaxial layer 11 (Kumamaru col. 3, lines 23-26). Kumamaru teaches at col. 4, lines 18-20 that the impurity concentration of layer 10 is 1×10^{11} / cm^2 to 1.2×10^{12} / cm^2. Since the denominator units of the impurity concentration of layer 11 is cm^3 (Kumamaru col. 4, line 24) and the denominator units of the impurity concentration units of layer 10 is cm^2, the impurity concentration of these two layers cannot be compared. Even assuming that they can be compared, since the numeric impurity concentration of Kumamaru layer 10 (1×10^{11} / cm^2 to 1.2×10^{12} / cm^2) is significantly less than the numeric impurity concentration of Kumamaru layer 11 (1×10^{14} / cm^3 to 5×10^{14} / cm^3), the impurity concentration of the second embedded diffusion layer 13 cannot be equal to or higher than the impurity concentration of the epitaxial layer 11 as recited in the claim. Thus, Kumamaru does not teach the above subject matter.

Claim 1 recites:

wherein a peak position of an impurity concentration of the first embedded diffusion layer resides at a first distance from the datum surface of the substrate and a peak position of an impurity concentration of the second embedded diffusion layer resides at a second distance from the datum surface of the substrate such that the first distance is greater than the second distance.

The Examiner presents Kumamaru buried layer 14 (Figure 10) as teaching the first embedded diffusion layer. Layer 14 (Figure 8) is formed from the upward diffusion of arsenic from region 8 (Figure 7) into layer 11 (Figure 8). Kumamaru does not have, nor has the Examiner cited, any teaching or suggestion with respect to the impurity concentration of layer 14. The Examiner presents region 13 (Figure 8) as teaching the second embedded diffusion layer. Kumamaru does not have, nor has the Examiner cited, any teaching or suggestion with respect to the impurity concentration of region 13.

In addition to the above, Kumamaru has no teaching with regard to either peak impurity concentrations or to relative peak impurity concentrations. Moreover, Kumamaru does not teach or even suggest that either region 13 or buried layer 14 has a peak impurity concentration. For the above reasons, Kumamaru does not teach the above subject matter.

Claim 1 recites:

a second embedded diffusion layer formed ... within a lower part of the epitaxial layer.

The Examiner admits in the appealed Office Action at page 4, lines 3-4 that Kumamaru does not depict the second embedded diffusion layer 13 as being formed within a lower part of the epitaxial layer 11. Here, the Examiner asserts at page 4, lines 4-7 that Kumamaru teaches at col. 3, lines 23-26 that the second embedded diffusion layer 13 is formed within a lower part of the epitaxial layer 11. However, Kumamaru teaches at col. 3, lines 47-51 that the inner bases 17 and 18 of Figure 10 reside in region 13 and that the collector 20 resides in a separate portion of region 13. Since the inner bases 17 and 18 and the collector 20 reside at the top part of the epitaxial layer 11, Kumamaru does not teach a second embedded diffusion layer formed within a lower part of the epitaxial layer.

Claim 1 recites:

a substrate defining a datum surface

In the appealed Office Action, the Examiner maintains on the one hand that one of ordinary skill in the art would have recognized that substrate 1 and epitaxial layer 5 of Kumamaru teaches the above substrate. (November 9, 2001 Office Action at page 3, line 6) However, on the other hand, the Examiner argues in the appealed Office Action at page 8, line 17, that those skilled in the art would have found that only substrate 1 of Kumamaru teaches the substrate of the invention. The Examiner's position is inconsistent. Moreover, the Examiner's position is based on clearly erroneous fact-finding since Kumamaru expressly teaches layer 5 as an epitaxial layer, not a substrate.

In Ex Parte Cook, 1995 WL 1747144 (Bd.Pat.App. & Interf. 1995) (Appeal No. 95-4435) (unpublished), the Board stated that where a legal conclusion is based on clearly erroneous fact-finding, the legal conclusion cannot stand. See also Ex Parte Krosner & Shackelford, 1995 WL 1747804 (Bd.Pat.App. & Interf. 1995) (Appeal No. 95-5021) (unpublished) (reversing a rejection under 35 U.S.C. §103, reasoning that the Examiner's interpretation was not reasonable because it was inconsistent). Since the Examiner's position is inconsistent and based on clearly erroneous fact-finding, the Examiner's legal conclusion cannot stand.

B. Watanabe

Claim 1 recites:

a second embedded diffusion layer formed ... within a lower part of the epitaxial layer,

In regards to Watanabe, the final product shown in Figure 8 no longer includes an epitaxial layer 3 formed above the second embedded diffusion layer 22". The section of epitaxial layer 3 in this region has been converted into a different element. In the

November 9, 2001 Office Action, the Examiner acknowledges that diffusion of impurities into a section of a layer converts that section into an element by writing at page 12, lines 9-10 "it is unclear how converting a section of a substrate into an element would not result in the element being located directly on the substrate."

The Examiner points to Figure 9 of Watanabe to teach the above subject matter. However, Figure 9 of Watanabe merely shows that what was once epitaxial layer 3 in this region has been converted into different elements, such as element 61-52-41'-3, element 52-41'-3, element 41'-3, element 22"-41"-3, element 21-22"-3, and element 21-22"-41'-3. Thus, Watanabe does not teach the above subject matter.

Claim 1 recites:

wherein the first embedded diffusion layer is not disposed within the second embedded diffusion layer

The Examiner presents element 21 (Figure 8) of Watanabe as teaching the first embedded diffusion layer and element 22" (Figure 8) of Watanabe as teaching the second embedded diffusion layer. Both Figure 8 and Figure 9 of Watanabe clearly show that first embedded diffusion layer 21 is disposed within the second embedded diffusion layer 22". Thus, Watanabe does not teach the above subject matter. Watanabe teaches disposing the first embedded diffusion layer 21 within the second embedded diffusion layer 22" to achieve a sufficient high breakdown voltage. (Watanabe col. 6, lines 18-28; col. 9, lines 31-33 and lines 51-53) Thus, one would not be motivated to modify the teachings of Watanabe in this regard.

Claim 1 preamble recites:

A semiconductor device having a first vertical type bipolar transistor and a second vertical type bipolar transistor having a breakdown voltage that is higher than a breakdown voltage of the first vertical type bipolar transistor

Watanabe discloses a semiconductor device having a NPN bipolar transistor 101 and an IIL (Integrated Injection Logic) device 201. However, Watanabe never discloses a semiconductor device having a first vertical type bipolar transistor and a second vertical type bipolar transistor having a breakdown voltage that is higher than a breakdown voltage of the first vertical type bipolar transistor.

The upper 22" portion of Watanabe Figure 8 is formed in element 41' and element 3 at a close position to base region 52. Accordingly, even if the lower 22" portion formed below element 41' exists in the IIL device 201, the breakdown voltage of the IIL device 201 is determined by the upper 22" portion due to the proximity of the upper 22" portion to the base region 52. Since the upper 22" portion is formed in element 41' and element 3 at a close position to base region 52, the breakdown voltage of the IIL device 201 is lower than that of the NPN bipolar transistor 101, whose distance between base region 53 and first embedded diffusion layer 21 is greater than the distance between base region 52 and the second embedded diffusion layer 22". Therefore, Watanabe never discloses "a first vertical type bipolar transistor and a second vertical type bipolar transistor having a breakdown voltage that is higher than a breakdown voltage of the first vertical type bipolar transistor" as recited in claim 1.

Here, the Examiner presents NPN bipolar transistor 101 as the first vertical type bipolar transistor and the IIL device 201 as the second vertical type bipolar transistor. As stated at Watanabe col. 1, lines 34-36, NPN transistors must have higher breakdown voltages than an IIL device formed on the same chip. (See also Watanabe col. 3, lines 25-29) In this way, transistor 101 is a high voltage transistor (Watanabe col. 3, lines 65-66) and transistor 201 is a high speed transistor (Watanabe col. 3, lines 67-68). Thus, Watanabe teaches that the breakdown voltage of the IIL device 201 must be lower than that of the NPN bipolar transistor 101. Since, under the Examiner's application of Watanabe, Watanabe teaches a

second vertical type bipolar transistor 201 having a breakdown voltage that is lower than a breakdown voltage of the first vertical type bipolar transistor 101, Watanabe does not teach the above subject matter.

C Conclusion Claims 1, 3, 22-23, and 25-26

For the above reasons, the Examiner has not made an adequate showing that claim 1, is obvious in view of the cited art. Accordingly, the Examiner has not made an adequate showing that claims 3, 22-23, and 25-26 are not obvious by reason of their dependency on claim 1.

III. CLAIM 4 IS NOT OBVIOUS

The Examiner rejected claim 4 under 35 U.S.C. §103(a) as unpatentable over Kumamaru (U.S. 4,379,726) or Watanabe (U.S. 4,258,379). However, the Examiner has not made an adequate showing that claim 4 is obvious in view of the cited art, thus claim 4 is not obvious.

Claim 4 recites:

wherein the impurity concentration of the second embedded diffusion layer includes a first impurity concentration that is equal to and includes a second impurity concentration that is greater than the impurity concentration of that portion of the epitaxial layer formed above the second embedded diffusion layer

In regard to Kumamaru, the Examiner states on page 6, lines 1-3 that Kumamaru has no teaching or suggestion regarding the above subject matter. However, the Examiner takes official notice that "it is well known in the art that diffused areas have concentration that follows natural distribution curve."

As explained more fully in Appellants' specification, there is no scientific basis for this statement because the actual distribution of impurities is the result of many factors, such as cycling of applied temperature, direction of applied temperature, initial distribution of

impurities, surrounding material, concentration distribution of surrounding material, as well as other factors. Moreover, the Examiner's use of the term "natural," as in a "natural distribution," is vague and indefinite. Thus, even assuming the official notice as true, the vague and indefinite official notice could not teach the claimed subject matter. Further, the Examiner has not shown that following a "natural" distribution curve would result in a relative distribution of impurity concentration between the Kumamaru epitaxial layer 11 and the Kumamaru second embedded diffusion layer 13 as recited in the claim. And, in addition, given that Kumamaru teaches inner bases 17 and 18 and collector 20 are formed in region 13 (Kumamaru col. 3, lines 46-52), Kumamaru does not teach any portion of the epitaxial layer 11 formed above the second embedded diffusion layer 13.

The Examiner provides an alternate theory to the above official notice. However, the Examiner's alternate theory, that n- type region 13 and n+ type layer 12 comprise the claimed second embedded diffusion layer, is not supported by the teachings of Kumamaru.

In regards to Watanabe, the final product shown in Figure 8 no longer includes an epitaxial layer 3 formed above the second embedded diffusion layer 22". The section of epitaxial layer 3 in this region has been converted into different elements, namely element 61-52-41'-3, element 52-41'-3, element 41'-3, element 22"-41"-3, element 21-22"-3, and element 21-22"-41'-3. In the November 9, 2001 Office Action, the Examiner acknowledges that diffusion of impurities into a section of a layer converts that section into an element by writing at page 12, lines 9-10 "it is unclear how converting a section of a substrate into an element would not result in the element being located directly on the substrate."

For the above reasons, the Examiner has not made an adequate showing that claim 4 is obvious in view of the cited art.

IV. CLAIM 6 IS NOT OBVIOUS

The Examiner rejected claim 6 under 35 U.S.C. §103(a) as unpatentable over Kumamaru (U.S. 4,379,726) or Watanabe (U.S. 4,258,379). However, the Examiner has not made an adequate showing that claim 6 is obvious in view of the cited art, thus claim 6 is not obvious.

Claim 6 recites:

wherein the substrate is a single substrate

The Examiner cites layer 1 and layer 5 of Kumamaru to teach the substrate of the claimed invention. Thus, Kumamaru does not teach the above subject matter.

Claim 6 recites:

wherein the impurity concentration of the second embedded diffusion layer is $1x10^{13}$ to $1x10^{15}$.

The Examiner employs Kumamaru region 13 as teaching the claimed second embedded diffusion layer. Since Kumamaru has no teaching or suggestion regarding the impurity concentration of region 13, Kumamaru does not teach the above subject matter.

The Examiner presents Watanabe layer 22" as teaching the claimed second embedded diffusion layer. The Examiner states that it would have been obvious to employ the $1x10^{13}$ to $1x10^{15}$ impurity concentration of Kumamaru region 13 in Watanabe layer 22" since it is a matter of design choice within the skills of an artisan, subject to routine experimentation and optimization. However, there is no teaching, suggestion, or incentive in the applied references which would have made it obvious to one of ordinary skill in the art to employ the $1x10^{13}$ to $1x10^{15}$ impurity concentration of Kumamaru region 13 in Watanabe layer 22," as required in Appellants' claim 6 on appeal. Moreover, given the lack of impurity concentration information in Kumamaru with regard to region 13, the Examiner has no basis for asserting that Kumamaru region 13 includes a $1x10^{13}$ to $1x10^{15}$ impurity concentration.

There is nothing in either Kumamaru or Watanabe to indicate that the impurity concentration of the second embedded diffusion layer would be considered by one of ordinary skill in the art to have been a result effective variable. Accordingly, there is no basis for the Examiner's position that the impurity concentration of the claimed second embedded diffusion layer would be considered by one of ordinary skill in the art to have been merely an "optimum" choice arrived at through routine experimentation.

Appellants asserts that the Examiner's conclusory statement about design choice is not "actual evidence" supporting a suggestion to combine. Moreover, the Examiner does not particularly identify any suggestion, teaching, or motivation to combine this design choice with any of the references. The Examiner has not presented any specific -- or even inferential -- findings concerning the identification of the relevant art, the level of ordinary skill in the art, the nature of the problem to be solved, or any other factual findings that might serve to support a proper obviousness analysis. Moreover, since the Examiner has not presented any sources from which to choose the recited range as a choice, there is no basis for stating that such a choice is a design choice.

Here, the obviousness analysis in the appealed Office Action is limited to a conclusory statement that recited range would be an obvious design choice. The Examiner's reference-by-reference, limitation-by-limitation analysis fails to demonstrate how the Kumamaru or Watanabe references teach or suggest their combination with the "skills of an artisan, subject to routine experimentation and optimization" to yield the claimed invention.

Since there are no statements by the Examiner to show that there was a suggestion, teaching, or motivation to combine the prior art references cited against claim 6, the Examiner's conclusion of obviousness, as a matter of law, cannot stand.

V. CLAIM 20 IS NOT OBVIOUS

The Examiner rejected claim 20 under 35 U.S.C. §103(a) as unpatentable over Kumamaru (U.S. 4,379,726). However, the Examiner has not made an adequate showing that claim 20 is obvious in view of the cited art, thus claim 20 is not obvious.

Claim 20 recites:

a second base layer ... disposed above the second embedded diffusion layer on the epitaxial layer to define a second epitaxial thickness between the second base layer and the second embedded diffusion layer

The Examiner presents Kumamaru region 13 to teach the second embedded diffusion layer. As Kumamaru states at col. 3, lines 46-48, the second base layer 18 is formed in region 13. Since the second base layer 18 is formed in region 13, the second base layer 18 is not formed above Kumamaru's second embedded diffusion layer 13 and does not define a second epitaxial thickness between the second base layer and the second embedded diffusion layer. Thus, Kumamaru does not teach the above subject matter.

Claim 20 recites:

wherein the first epitaxial thickness is less than the second epitaxial thickness

Since Kumamaru does not define a second epitaxial thickness, Kumamaru does not teach the above subject matter.

Claim 20 recites:

wherein only the epitaxial layer is disposed between the base layer and the second embedded diffusion layer.

The Examiner presents Kumamaru region 13 to teach the second embedded diffusion layer and layer 11 to teach the epitaxial layer. As Kumamaru states at col. 3, lines 46-48, the second base layer 18 is formed in region 13. Since the second base layer 18 is formed in

region 13, Kumamaru does not teach or suggest that only the epitaxial layer is disposed between the base layer and the second embedded diffusion layer.

For the above reasons, the Examiner has not made an adequate showing that claim 20 is obvious in view of the cited art.

VI. CLAIM 21 IS NOT OBVIOUS

The Examiner rejected claim 21 under 35 U.S.C. §103(a) as unpatentable over Kumamaru (U.S. 4,379,726) or Watanabe (U.S. 4,258,379). However, the Examiner has not made an adequate showing that claim 21 is obvious in view of the cited art, thus claim 21 is not obvious.

Claim 21 recites:

wherein the impurity concentration of the second embedded diffusion layer is approximately equal to or higher than the epitaxial impurity concentration at all distances greater than the second distance.

The Examiner has not addressed the subject matter of this claim. Rather, the Examiner has left up to Appellants to speculate as to the proper application of the art to the claims. Since the Examiner has not adequately addressed the above subject matter, the Examiner has not presented a prima facie case of obviousness for this claim. Thus, the Examiner's rejection of claim 21 cannot stand.

The Examiner presents Kumamaru element 11 as teaching the epitaxial layer and Kumamaru region 13 as teaching the second embedded diffusion layer. The impurity concentration of Kumamaru element 11 is $1x10^{14}/cm^3$ to $5x10^{14}/cm^3$. (Kumamaru col. 4, lines 21-24) Kumamaru has no teaching or suggestion with regard to the impurity concentration of region 13. Thus, the Examiner's rejection of claim 21 cannot stand.

The Examiner presents Watanabe element 22" (Figure 8) as teaching the second embedded diffusion layer and Watanabe element 3 as teaching the epitaxial layer. Claim 21

depends on claim 1. In regards to the second distance term in claim 21, claim 1 recites that "*a peak position of an impurity concentration of the second embedded diffusion layer resides at a second distance from the datum surface of the substrate*". As seen in Figure 9 of Watanabe, the impurity concentration of the Watanabe second embedded diffusion layer 22" is less than the epitaxial impurity concentration (element 3) at a distance from the datum surface of Watanabe substrate 1 along line Y-Y' in Figure 8 beyond the peak position (Figure 9) of the impurity concentration of the Watanabe second embedded diffusion layer 22". Accordingly, Watanabe does not teach the above limitation.

For the above reasons, the Examiner has not made an adequate showing that claim 21 is obvious in view of the cited art.

VII. CLAIM 24 IS NOT OBVIOUS

The Examiner rejected claim 24 under 35 U.S.C. §103(a) as unpatentable over Kumamaru (U.S. 4,379,726). However, the Examiner has not made an adequate showing that claim 24 is obvious in view of the cited art, thus claim 24 is not obvious.

Claim 24 recites:

wherein only the epitaxial layer is disposed between the base layer and the second embedded diffusion layer.

The Examiner presents Kumamaru region 13 to teach the second embedded diffusion layer and layer 11 to teach the epitaxial layer. As Kumamaru states at col. 3, lines 46-48, the second base layer 18 is formed in region 13. Since the second base layer 18 is formed in region 13, Kumamaru does not teach or suggest that only the epitaxial layer is disposed between the base layer and the second embedded diffusion layer.

For the above reasons, the Examiner has not made an adequate showing that claim 24 is obvious in view of the cited art.

VIII. CLAIM 27 IS NOT OBVIOUS

The Examiner rejected claim 27 under 35 U.S.C. §103(a) as unpatentable over Kumamaru (U.S. 4,379,726) in view of Watanabe (U.S. 4,258,379). However, the Examiner has not made an adequate showing that independent claim 27 is obvious in view of the cited art, thus claim 27 is not obvious.

Claim 27 recites:

a high voltage diffusion layer comprising a first surface disposed at a second height, wherein the second height is substantially at the datum;

The Examiner presents the interface between substrate 1 and epitaxial layer 5 of Kumamaru as teaching the datum. Moreover, the Examiner presents region 13 (Figure 8) as teaching the high voltage diffusion layer. However, Kumamaru teaches at col. 3, lines 47-51 that the inner bases 17 and 18 of Figure 10 reside in region 13. Thus, the second height of region 13 touches the inner bases 17 and 18. Since the second height of region 13 touches the inner bases 17 and 18, the second height of Kumamaru region 13 is not substantially at the datum.

Claim 27 recites:

wherein only the epitaxial layer is disposed between the first surface of the high voltage diffusion layer and the lower surface of the high voltage base layer,

The Examiner presents Kumamaru region 13 to teach the high voltage diffusion layer and layer 11 to teach the epitaxial layer. As Kumamaru states at col. 3, lines 46-48, the second base layer 18 is formed in region 13. Since the second base layer 18 is formed in region 13, Kumamaru does not teach or suggest that only the epitaxial layer is disposed between the base layer and the second embedded diffusion layer.

Claim 27 recites:

wherein the high speed (HS) diffusion layer comprises a peak impurity concentration (HSPIC) value and wherein the high voltage (HV) diffusion layer comprises a peak impurity concentration (HVPIC) value, such that the high voltage peak impurity concentration (HVPIC) value ***is less than*** *the high speed peak impurity concentration (HSPIC) value*

The Examiner presents Kumamaru region 13 to teach the high voltage diffusion layer and layer 14 to teach the high speed diffusion layer. However, Kumamaru lacks any teaching or suggestion as to the high voltage peak impurity concentration with regard to region 13. Moreover, Kumamaru teaches at col. 3, lines 47-51 that the inner bases 17 and 18 of Figure 10 reside in region 13. Thus, the second height of region 13 touches the inner bases 17 and 18. Here, the HVPIC value would be greater than the HSPIC value.

The Examiner looks to Figures 4 and 9 of Watanabe to find teaching with regard to a high voltage peak impurity concentration of the high voltage layer. Watanabe Figure 4 shows that the high voltage peak impurity concentration value 21 is greater than the high speed peak impurity concentration value 22'. Moreover, Watanabe Figure 9 shows that the high voltage peak impurity concentration value 21 is greater than the high speed peak impurity concentration value 22".

Claim 27 recites:

wherein each impurity concentration of the high voltage diffusion layer that is located between the high voltage peak impurity concentration (HVPIC) and the datum is higher than each impurity concentration of the epitaxial layer that is located between the first surface of the high voltage diffusion layer and the lower surface of the high voltage base layer.

The Examiner presents Kumamaru region 13 to teach the high voltage diffusion layer and layer 11 to teach the epitaxial layer. However, Kumamaru lacks any teaching or suggestion as to the high voltage peak impurity concentration with regard to region 13.

The Examiner looks to Figures 4 and 9 of Watanabe to find teaching with regard to a HVPIC of the high voltage layer. The Examiner employs Watanabe layer 3 to teach the epitaxial layer (Appealed Office Action, page 4, line 11). Watanabe Figure 4 and Figure 9 both show impurity concentrations of the high voltage diffusion layer 21 that are lower than the impurity concentration of Watanabe epitaxial layer 3 on both sides of the peak.

To this, the Examiner then asserts in the appealed Office Action at page 10, lines 8-15 that it would be obvious to a skilled person to modify the teachings of Watanabe and apply these modified teachings to Kumamaru to teach the claimed subject matter since it is a matter of design choice within the skills of an artisan, subject to routine experimentation and optimization.

There is no teaching, suggestion, or incentive in the applied references that would have made it obvious to one of ordinary skill in the art to modify the teachings of Watanabe or to modify the teachings of Watanabe and apply these modified teachings to Kumamaru. Moreover, there is nothing in either Kumamaru or Watanabe to indicate that the HVPIC relative to the impurity concentration of the epitaxial layer would be considered by one of ordinary skill in the art to have been a result effective variable. Accordingly, there is no basis for the Examiner's position that the claimed subject matter would be considered by one of ordinary skill in the art to have been merely an "optimum" choice arrived at through routine experimentation.

For the above reasons, the Examiner has not made an adequate showing that claim 27 is obvious in view of the cited art.

IX. CLAIM 28 IS NOT OBVIOUS

The Examiner rejected claim 28 under 35 U.S.C. §103(a) as unpatentable over Kumamaru (U.S. 4,379,726) and Watanabe (U.S. 4,258,379) as applied to claim 28, and

further in view of Admitted Prior Art. However, the Examiner has not made an adequate showing that claim 28 is obvious in view of the cited art, thus claim 28 is not obvious.

Claim 28 recites:

wherein the high speed (HS) diffusion layer comprises a peak impurity concentration (HSPIC) value that is disposed at distance Y_{HSPIC} below the datum, wherein the high voltage (HV) diffusion layer comprises a peak impurity concentration (HVPIC) value that is disposed at distance Y_{HVPIC} below the datum, and wherein $Y_{HVPIC} > Y_{HSPIC}$.

The Examiner relies on Admitted Prior Art Figure 3 and Figure 4 to teach $Y_{HVPIC} > Y_{HSPIC}$. However, the claimed datum resides at the surface of the substrate and the high voltage diffusion layer. Since the section views shown do not show such a datum, the Examiner cannot employ the Admitted Prior Art to draw the conclusion that claim 28 is obvious.

X. CLAIM 29 IS NOT OBVIOUS

The Examiner rejected claim 29 under 35 U.S.C. §103(a) as unpatentable over Kumamaru (U.S. 4,379,726) in view of Watanabe (U.S. 4,258,379). However, the Examiner has not made an adequate showing that claim 29 is obvious in view of the cited art, thus claim 29 is not obvious.

Claim 29 recites:

wherein the epitaxial layer between the first surface of the high speed diffusion layer and the lower surface of the high speed base layer defines a thin collector layer, wherein the epitaxial layer between the first surface of the high voltage diffusion layer and the lower surface of the high voltage base layer defines a thick collector layer, wherein the thick collector layer is thicker than the thin collector layer.

The Examiner employs Kumamaru to teach the above subject matter. Since the high voltage base layer 17 of Kumamaru is formed in the high voltage diffusion layer 13 of

Kumamaru (Kumamaru col. 3, lines 46-48), Kumamaru teaches that the thick collector layer is thinner than the thin collector layer. Thus, Kumamaru does not teach the above subject matter.

For the above reasons, the Examiner has not made an adequate showing that claim 29 is obvious in view of the cited art.

CONCLUSION:

Appellants submits that the subject matter of the claims on appeal is not found or suggested in any of the references cited by the Examiner, taken singly or in combination. Thus, the Examiner has not established a prima facie case of obviousness with respect to the subject matter of the rejected claims.

Appellants respectfully submits that the Examiner is in error both in law and in fact in rejecting claims 1, 3-4, 6, and 20-29 and earnestly solicits reversal of the decision of the Examiner to reject claims 1, 3-4, 6, and 20-29 in view of the cited art. Appellants solicits allowance of all claims.

Respectfully submitted,
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CERTIFICATE OF MAILING

I hereby certify that this original and two copies of this correspondence is being deposited with the United States Postal Service in an envelope addressed to: Board of Patent Appeals and Interferences, Commissioner for Patents, Washington, D.C. 20231 on February 8, 2002.

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Rose M. Garza Date: February 8, 2002

APPENDIX TO APPELLANTS' MAIN BRIEF ON APPEAL

1. A semiconductor device having a first vertical type bipolar transistor and a second vertical type bipolar transistor having a breakdown voltage that is higher than a breakdown voltage of the first vertical type bipolar transistor, the semiconductor device comprising:

a substrate defining a datum surface, wherein the substrate is a first conductive type substrate;

an epitaxial layer formed on the substrate above the datum surface;

a first embedded diffusion layer formed as part of a first vertical type bipolar transistor in a first upper part of the substrate and in the epitaxial layer;

a second embedded diffusion layer formed as part of a second vertical type bipolar transistor directly on the substrate, in a second upper part of the substrate, and within a lower part of the epitaxial layer,

wherein the first embedded diffusion layer is not disposed within the second embedded diffusion layer,

wherein the second embedded diffusion layer is a second conductive type second embedded diffusion layer that is a different conductive type from the first conductive type substrate and includes an impurity concentration that is less than the impurity concentration of the first embedded diffusion layer and is equal to or higher than that of the epitaxial layer, and

wherein a peak position of an impurity concentration of the first embedded diffusion layer resides at a first distance from the datum surface of the substrate and a peak position of an impurity concentration of the second embedded diffusion layer resides at a second distance from the datum surface of the substrate such that the first distance is greater than the second distance.

3. A semiconductor device according to claim 1,

wherein a bottom of the first embedded diffusion layer is formed at a third distance from the datum surface of the substrate, and

wherein a midpoint of the second embedded diffusion layer is formed at a fourth distance from the datum surface of the substrate such that the fourth distance is greater than the third distance.

4. A semiconductor device according to claim 1, wherein the impurity concentration of the second embedded diffusion layer includes a first impurity concentration that is equal to and includes a second impurity concentration that is greater than the impurity concentration of that portion of the epitaxial layer formed above the second embedded diffusion layer.

6. A semiconductor device according to claim 1, wherein the substrate is a single substrate, wherein the datum surface is a bottom surface of the substrate, and wherein the impurity concentration of the second embedded diffusion layer is $1x10^{13}$ to $1x10^{15}$.

20. A semiconductor device according to claim 1, further comprising:

a first base layer disposed between two first graft base layers and disposed above the first embedded diffusion layer on the epitaxial layer to define a first epitaxial thickness between the first base layer and the first embedded diffusion layer; and

a second base layer disposed between two second graft base layers and disposed above the second embedded diffusion layer on the epitaxial layer to define a second epitaxial thickness between the second base layer and the second embedded diffusion layer,

wherein the first epitaxial thickness is less than the second epitaxial thickness, and

wherein only the epitaxial layer is disposed between the base layer and the second embedded diffusion layer.

21. A semiconductor device according to claim 1, wherein the impurity concentration of the second embedded diffusion layer is approximately equal to or higher than the epitaxial impurity concentration at all distances greater than the second distance.

22. A semiconductor device according to claim 1, wherein a peak position of an impurity concentration of the second embedded diffusion layer resides at a distance from the datum surface of the substrate that is approximately equal to a location of the bottom of the first embedded diffusion layer from the datum surface of the substrate.

23. A semiconductor device according to claim 1, wherein the first vertical type bipolar transistor defines a voltage that is different than a voltage of the a second vertical type bipolar transistor,

wherein the substrate is a silicon substrate,

wherein the first embedded diffusion layer includes an impurity concentration that is higher than the epitaxial impurity concentration, and

wherein the second embedded diffusion layer defines a conductive type that is the same as the epitaxial conductive type.

24. A semiconductor device according to claim 1, wherein the second vertical type bipolar transistor includes a base layer disposed between two graft base layers and wherein only the epitaxial layer is disposed between the base layer and the second embedded diffusion layer.

25. The semiconductor device of claim 1, wherein the substrate is a P-type substrate and wherein the second embedded diffusion layer is an N+-type second embedded diffusion layer.

26. The semiconductor device of claim 1, wherein the substrate is a N-type substrate and wherein the second embedded diffusion layer is an P-type second embedded diffusion layer.

27. A semiconductor device, comprising:

a substrate comprising a first surface that defines a datum;

a high speed diffusion layer comprising a first surface disposed above the datum at a first height;

a high voltage diffusion layer comprising a first surface disposed at a second height, wherein the second height is substantially at the datum;

a high speed base layer comprising a lower surface that faces the first surface of the high speed diffusion layer and is disposed at a first speed height from the datum;

a high voltage base layer comprising a lower surface that faces the second surface of the high voltage diffusion layer and is disposed at a first voltage height from the datum,

wherein the first speed height of the high speed base layer is equal to the first voltage height of the high voltage base layer;

an epitaxial layer, wherein the epitaxial layer is disposed between the first surface of the high speed diffusion layer and the lower surface of the high speed base layer, and wherein only the epitaxial layer is disposed between the first surface of the high voltage diffusion layer and the lower surface of the high voltage base layer,

wherein the high speed (HS) diffusion layer comprises a peak impurity concentration (HSPIC) value and wherein the high voltage (HV) diffusion layer comprises a peak impurity concentration (HVPIC) value, such that the high voltage peak impurity concentration (HVPIC) value is less than the high speed peak impurity concentration (HSPIC) value, and

wherein each impurity concentration of the high voltage diffusion layer that is located between the high voltage peak impurity concentration (HVPIC) and the datum is higher than each impurity concentration of the epitaxial layer that is located between the first surface of the high voltage diffusion layer and the lower surface of the high voltage base layer.

28. The semiconductor device of claim 27,

wherein the high speed (HS) diffusion layer comprises a peak impurity concentration (HSPIC) value that is disposed at distance Y_{HSPIC} below the datum,

wherein the high voltage (HV) diffusion layer comprises a peak impurity concentration (HVPIC) value that is disposed at distance Y_{HVPIC} below the datum, and

wherein $Y_{HVPIC} > Y_{HSPIC}$.

29. The semiconductor device of claim 27,

wherein the epitaxial layer between the first surface of the high speed diffusion layer and the lower surface of the high speed base layer defines a thin collector layer, wherein the epitaxial layer between the first surface of the high voltage diffusion layer and the lower surface of the high voltage base layer defines a thick collector layer,

wherein the thick collector layer is thicker than the thin collector layer.